

Thermal Runaway Event Analysis – Gas, Temperature and Pressure

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Tests were conducted on lithium-ion, lithium-pouch, and lithium-metal cells of various cathode chemistries and sizes to evaluate their thermal runaway effects. A 21.7 liter pressure vessel is equipped with thermocouples to measure the ambient and cell case temperature and a pressure transducer to measure the pressure rise and quantify the gas release from the individual lithium cells. The maximum cell case temperature, thermal runaway onset cell case temperature and the peak percent pressure rise were measured and the gases were collected and analyzed for percent hydrogen, carbon monoxide, carbon dioxide and hydrocarbon content.

CR123a 3V 1500mAh lithium manganese dioxide spiral non rechargeable batteries were forced into thermal runaway by overheating and overcharging to determine if and how various testing methods affect a batteries thermal runaway event. The overheat method was the most consistent and quickest method in producing a thermal runaway event. The DC overcharge method did not consistently bring the cell into thermal runaway.

Tests were conducted with 18650 sized lithium cobalt oxide 3.7V 2600mAh and 3.7V 2500mAh lithium cobalt oxide polymer rechargeable cells at 30% state of charge (SOC) to determine if and how the heat rate affects a cell's thermal runaway event. Individual batteries were heated at 5°C/min, 10°C/min, 15°C/min, 20°C/min and 40°C/min. It is found that changing the heat rate significantly changes the thermal runaway reaction for 18650 and observably changes the thermal runaway reaction for pouch cells.

Tests were conducted with three differently shaped lithium ion rechargeable 3.7V 500mAh cells at 100% SOC. Two differently sized lithium polymer cells and a lithium nickel manganese cobalt oxide button cell are tested. The cells were forced into thermal runaway using the overheat method at 20°C/min to determine if small batteries are a threat to aircraft safety. The mean maximum cell case temperature is 571°C, the mean volume of thermal runaway vent gas is 0.76L, the mean percent pressure rise is 16.6% and the LFL is calculated to be 9.1%